



Workshop on CSR in Storage Rings

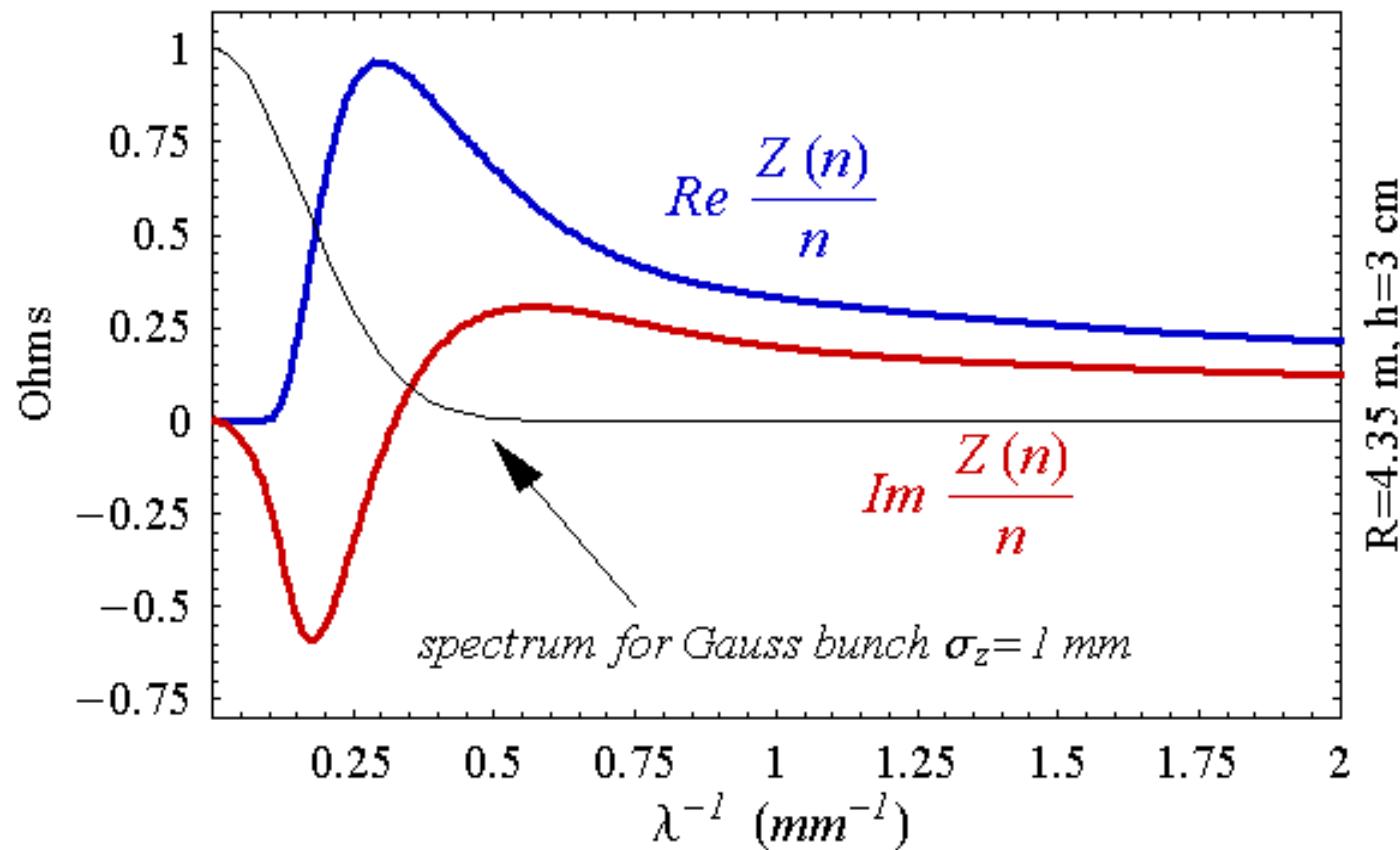
Napa, October 27-28, 2002

Preliminary Study of CSR Steady-Emission Regime

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SLAC

(with R. Warnock and R. Ruth)

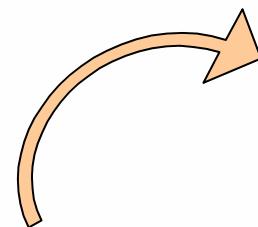
CSR Impedance for BESSY (prll. plates)



BESSY-like parameters used in calculation

Energy	1.7 GeV
Rev. frequency	1.25 MHz
Synch. frequency when $\alpha = 10^{-4}$	2.74 KHz
Local radius	4.35 m
Chamber height	3 cm
Long. damping time	8 ms
Natural energy spread	.1 %

Computing the Radiation Power



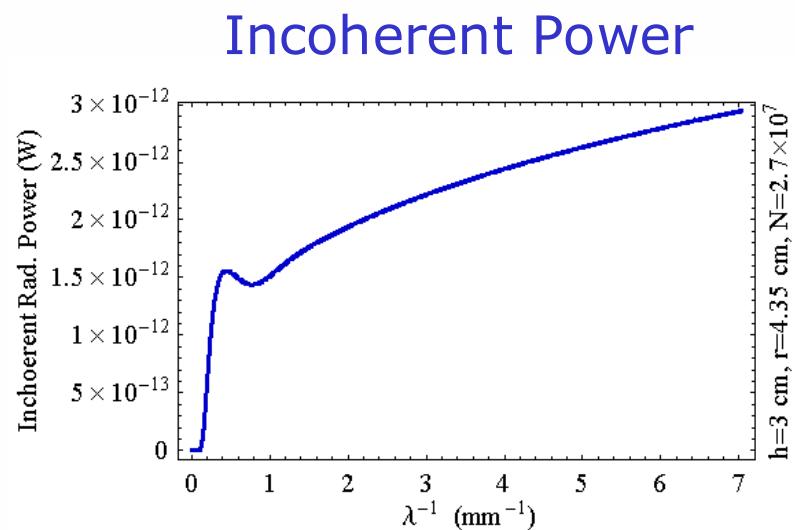
Fourier component
of bunch distribution

$$P_n^{coh} = 2(eN\omega_0)^2 \operatorname{Re} Z(n) |\lambda_n|^2$$

$$P_n^{incoh} = 2N(e\omega_0)^2 \operatorname{Re} Z(n) / (2\pi)^2$$

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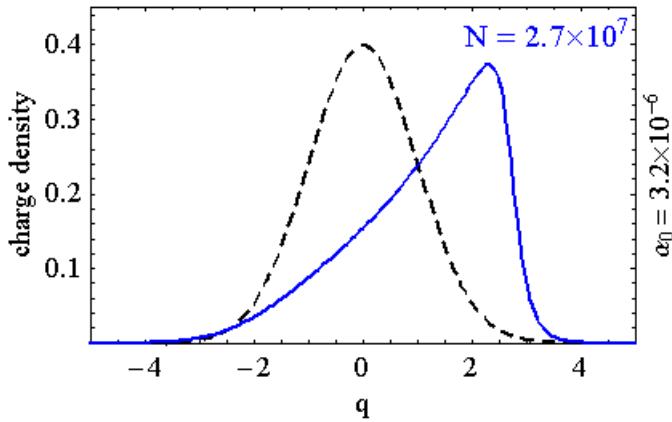
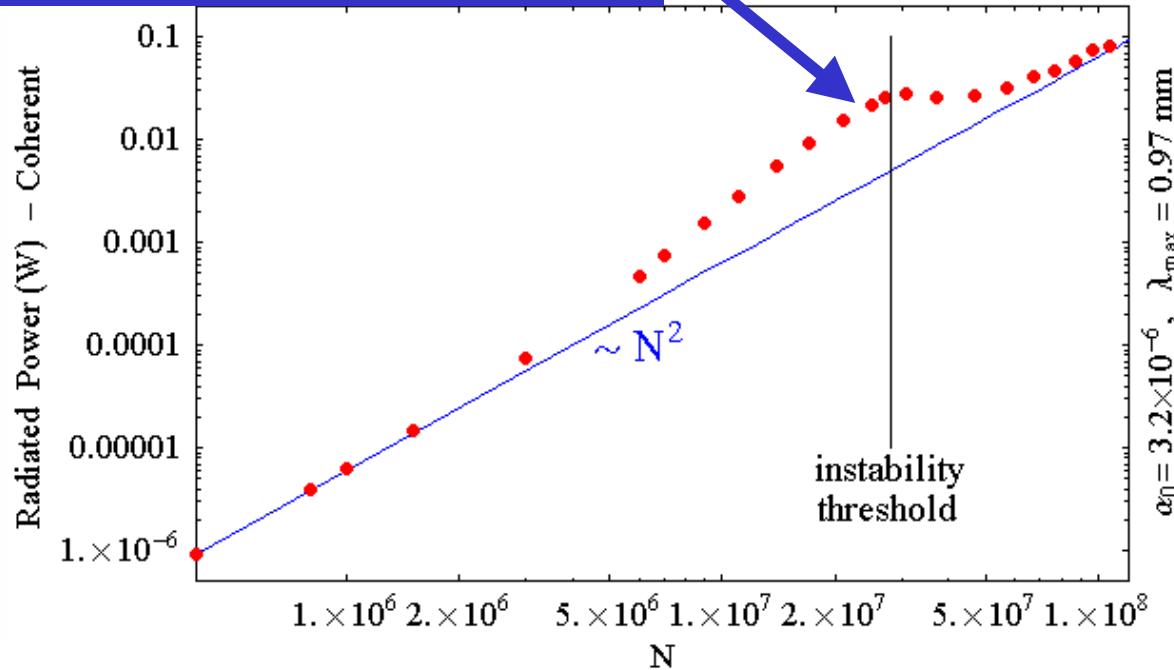
M. Venturini



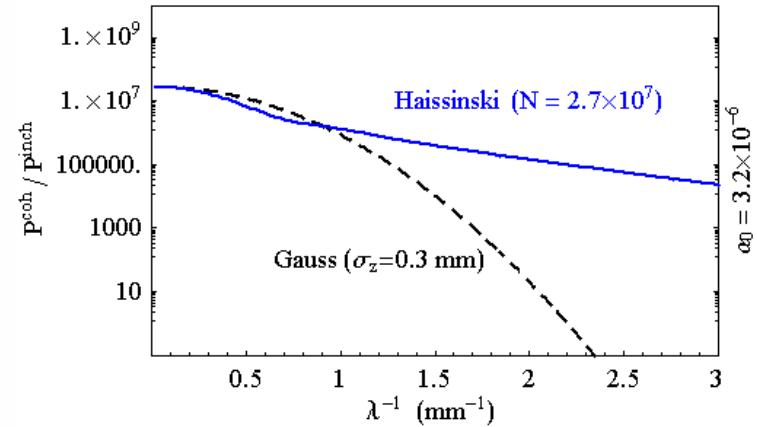
(Coherent) Radiated Power vs. N

$$\alpha_0 = 3.2 \times 10^{-6}, \sigma_z = 0.3 \text{ mm}$$

below instability threshold



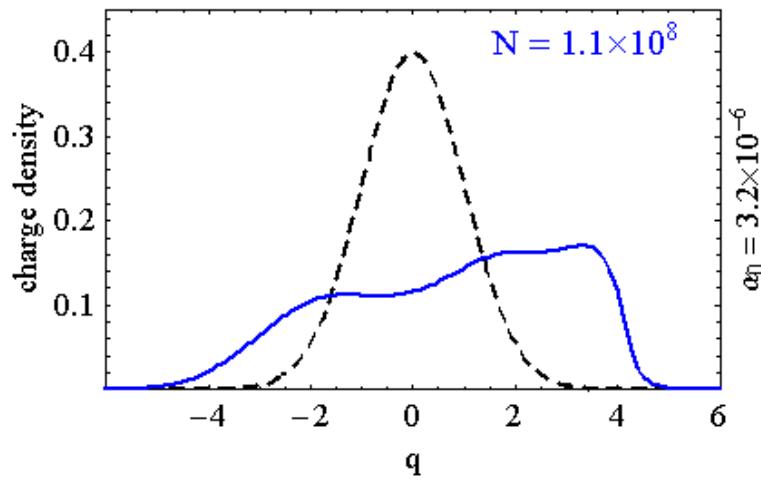
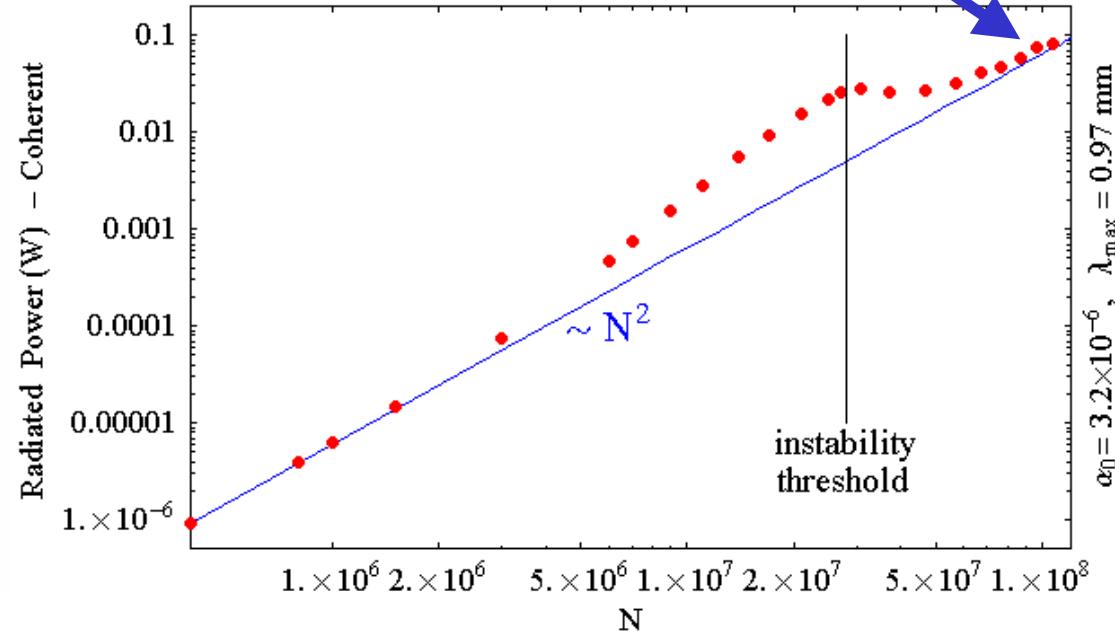
M. Venturini



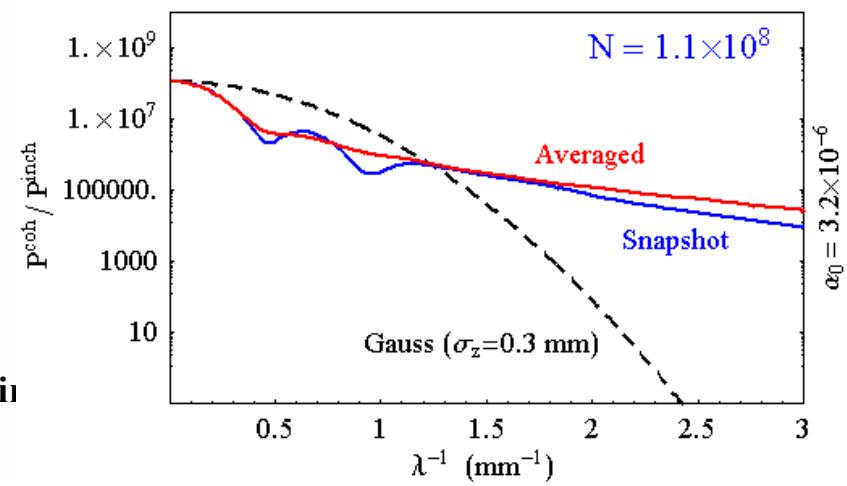
(Coherent) Radiated Power vs. N

$$\alpha_0 = 3.2 \times 10^{-6}, \sigma_z = 0.3 \text{ mm}$$

above instability threshold



M. Venturi



Corrections to Mom. Compaction (zero-current limit)

$$\alpha = \alpha_0 + \alpha_1 \delta + \alpha_2 \delta^2$$

$$q = z / \sigma_z, \quad p = -\delta = -\Delta E / E_0, \quad \tau = \omega_s t$$

$$H = \frac{1}{2} \left(p^2 + \frac{\alpha_1}{3\alpha_0} \sigma_\delta p^3 + \frac{\alpha_2}{4\alpha_0} \sigma_\delta^2 p^4 \right) + \frac{1}{2} q^2$$

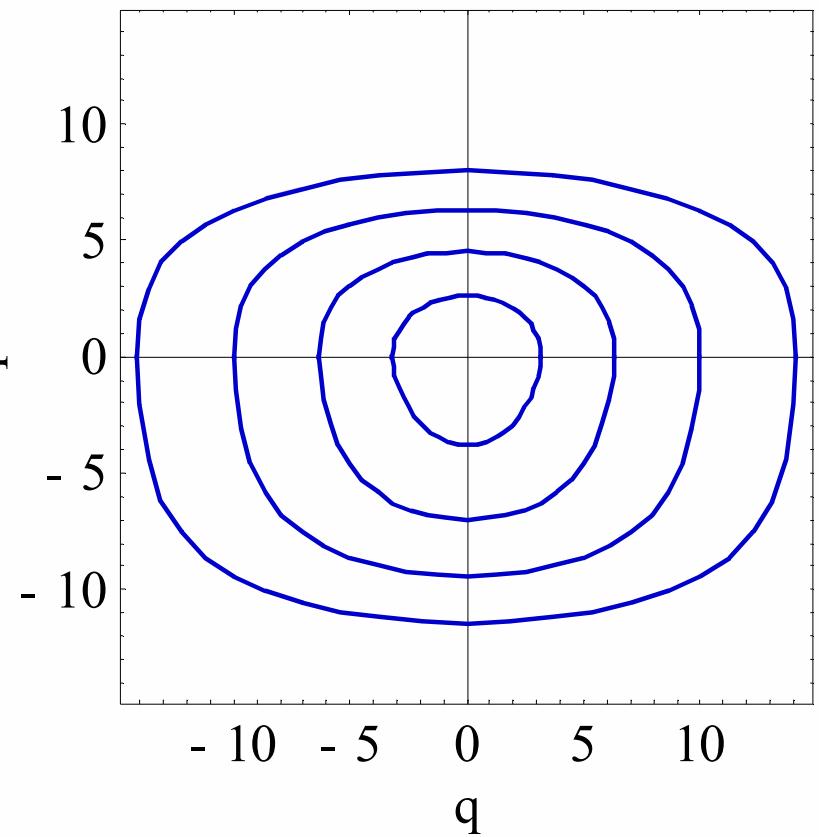
$$\alpha_0 = 3.2 \times 10^{-6}$$

$$\alpha_1 = 1.9 \times 10^{-3}$$

$$\alpha_2 = 0.4$$

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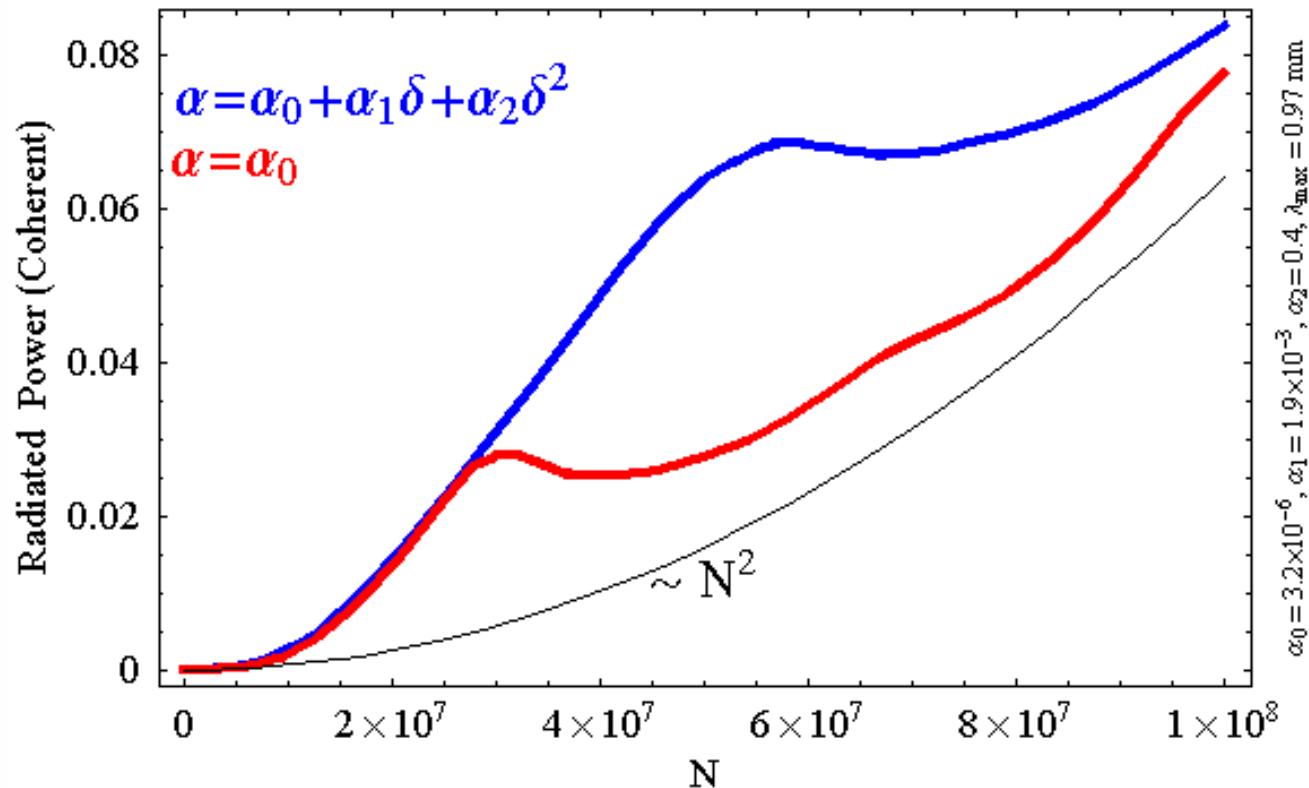
Corrections to Mom. Compaction (zero current limit) cont.'d

- Equilibrium is **not Haissinski**.
- q and p are **not separable**.
- Bunch centroid shifts.

$$\langle q \rangle \approx -\frac{2}{t_d \omega_s} \frac{\alpha_1}{\alpha_0} \sigma_\delta \langle p^2 \rangle$$

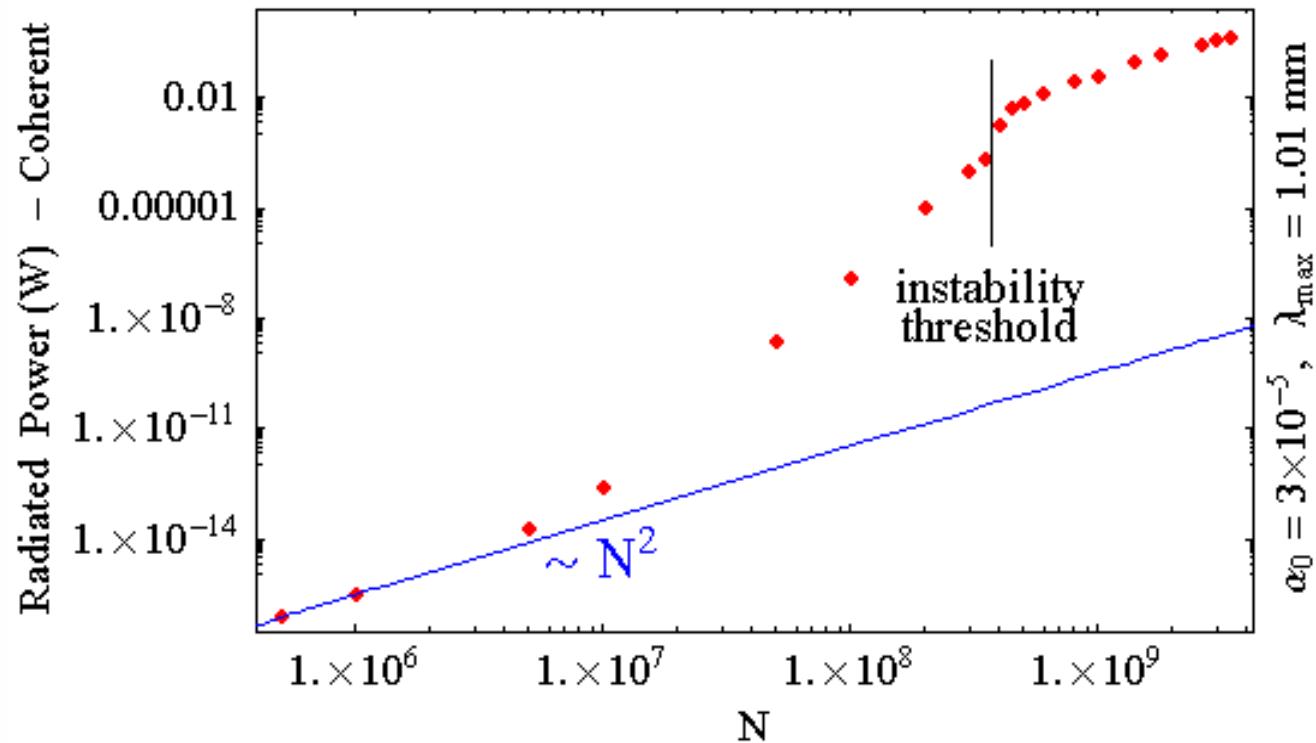
$$\langle p \rangle \approx -\frac{\alpha_1}{\alpha_0} \sigma_\delta \langle p^2 \rangle$$

(Coherent) Radiated Power with Corrections to Momentum Compaction



(Coherent) Radiated Power

$$\alpha_0 = 3 \times 10^{-5}, \sigma_z = 0.98 \text{ mm}$$



Tentative Conclusions

- Potential well distortion due to CSR may be significant for small bunches
- Enhancement of radiaton power $> N^2$
- Effect of instability to be further investigated.
- Time structure of coherent signal depends on proximity to instability.